THE VITAMIN D CONTENT OF EGG YOLK*

BY H. D. BRANION,

Department of Poultry Husbandry, Ontario Agricultural College, Guelph,

T. G. H. DRAKE AND F. F. TISDALL,

Department of Pædiatrics, University of Toronto, and the Hospital for Sick Children, Toronto

MOST foods ordinarily consumed are devoid of vitamin D. Traces of this vitamin are found in summer milk and summer butter, but egg yolk is the only foodstuff that contains appreciable amounts of vitamin D, with the exception of fish oils. The vitamin D in egg yolk, together with its high concentrate of grade A protein and phosphorus, makes it a particularly valuable food.

The presence of appreciable amounts of vitamin D in egg yolk was first demonstrated by Mellanby,[1] who cured rickets in a dog by the addition of egg yolk to a rickets-producing diet. Hess[2] reported that egg yolk had considerable antirachitic potency, since its inclusion in a diet cured or prevented rickets in rats. In addition, he carried out prophylactic treatment of twelve infants to forestall the development of rickets in the winter months. One egg yolk per day was added to their diet in December, and in March no clinical nor x-ray signs of rickets were observed. The level of inorganic blood phosphorus did not show the usual seasonal ebb but was maintained at the summer level. He later found that 0.05 gram fed daily would protect rats on a low phosphorus diet from rickets, but was less effective when rats were on low calcium diets. Boiling the egg yolk for twenty minutes did not appreciably lower the vitamin D content, but keeping it in a dried state caused deterioration. The yolk also conferred protection when injected subcutaneously.

Casparis, Shipley and Kramer[3] demonstrated definite healing of rickets, in most cases severe, in seven negro children upon adding one or two eggs daily to a diet of cereal and milk. They also confirmed the previous findings with rats. Collier[4] prevented the development of leg weakness in chicks, a condition essentially similar to rickets in mammals, by feeding them hard boiled eggs. Tso[5] reported that egg yolk in small quantities furnished a vitamin-like substance which enabled the body to mobilize and economically utilize its apparently limited supply of calcium. The Chinese method of preserving ducks' eggs did not seem to destroy the antirachitic value of the yolk when incorporated in the diet to the extent of 5 per cent.

THE EFFECT OF THE RATION OF THE HEN ON THE VITAMIN D CONTENT OF EGG YOLK

The full details of this aspect of the present investigation will be given in a separate communication and only the points of medical interest will be reported here. The hens, consisting of Barred Plymouth Rock pullets, were divided into groups of 14 each, confined indoors and fed a standard basal diet. Group I served as control. To the food of Group 2 was added 1 per cent 2.5D cod liver oil (the average standard cod liver oil); to Group 3, 1 per cent 10D cod liver oil (the average standard cod liver oil fortified with viosterol); to Group 4, 1 per cent 2.5D viosterol; to Group 5, 1 per cent 250D viosterol, and to Group 6, 1 per cent 25,000D viosterol. The birds were started in these groups in January and the eggs laid by each group during the first two weeks of August were pooled for assay. The vitamin D potency of the egg yolk was assayed by the standard line test technique of Steenbock and Black,[6] a modification of that of McCollum, Simmonds, Shipley and Park.[7] The minimum amount of fresh egg yolk necessary to give a two-plus healing of rickets was determined in each case. The num-

* Read before the annual meeting of the Canadian Society for the Study of Diseases of Children, 1933.

This work formed part of a thesis presented by one of the authors, (H.D.B.) for the degree of Doctor of Philosophy, in the Department of Biochemistry, University of Toronto.

ber of Steenbock vitamin D units per average egg yolk is given in Table I. These results show that the vitamin D content of egg yolk can be markedly influenced by the addition of vitamin D to the diet of the hen.

TABLE I.

STEENBOCK VITAMIN D UNITS PER AVERAGE EGG YOLK

Group	*Diet*	*Vitamin D Units per Average Egg Yolk*
1	Basal	3.8
2	" + 2.5D cod liver oil 1%	30.0
3	" + 10D cod liver oil 1%	57.0
4	" + 2.5D viosterol 1%	30.0
5	" + 250D viosterol 1%	818.0
6	" + 25,000D viosterol 1%	18,000.0

THE EFFECT OF EXPOSURE OF HENS TO ULTRAVIOLET RAYS ON THE VITAMIN D CONTENT OF EGG YOLK

Hens were placed on the basal diet and divided into three groups of twenty birds each. The groups were confined in pens the fronts of which were open, the birds thus receiving whatever sunshine was available. The number of hours of available sunshine during the period of the investigation was as follows: January, 30; February, 95; March, 117; April, 185; May, 218, June, 271, and July, 254. In addition Group 2 was irradiated at a distance of three feet by a mercury vapour quartz lamp for twenty minutes daily, except Sunday. Group 3 was under the same conditions as Group 1, with the addition of 1 per cent 2.5D cod liver oil. Two dozen eggs from each group laid during the second week of each month were collected and the yolks pooled for assay. The results are given in Table II.

TABLE II.

STEENBOCK VITAMIN D UNITS PER AVERAGE EGG YOLK

	Control Group	*Irradiated Group*	*1 Per Cent Cod Liver Oil Group*
	Units	Units	Units
January....	4.5	5.6	30.0
February...	3.9	6.0	27.7
April.....	4.2	5.1	25.7
May.....	5.1	6.0	28.1
June.....	4.5	5.3	30.0
July.....	4.7	5.0	32.1

It is evident from these results that exposure of hens to sunshine or ultraviolet rays from a mercury vapour lamp under the conditions of the investigation had very little effect in increasing the vitamin D content of the egg yolk, in contrast to the results obtained by the addition of cod liver oil to the diet.

THE VITAMIN D CONTENT OF MARKET EGGS

Since there is a wide variation in the rations fed to laying hens, especially in the amount of vitamin D supplied, there are probably just as wide variations in the antirachitic potency of eggs received by the consuming public. In order to test such variations, one dozen fresh eggs, known as "fresh extras", were purchased monthly from each of twelve different producers. The yolks from one egg of each dozen were pooled for assay. The results of the vitamin D assays are shown in Table III. For comparison the values obtained for the yolks laid by hens receiving the basal diet supplemented by 1 per cent of cod liver oil, the usually recommended dosage, and the control group receiving no added vitamin D are included.

TABLE III.

STEENBOCK VITAMIN D UNITS PER AVERAGE EGG YOLK

	Market Fresh Extras	*Basal Diet*	*Basal Diet + 1 Per cent Cod Liver Oil*
	Units	Units	Units
January....	10.0	4.5	30.0
February...	7.5	3.9	27.7
March.....	9.0	...	....
April.....	10.0	4.2	25.7
May.....	7.5	5.1	28.1
June.....	9.0	4.5	30.0
July.....	7.5	4.7	32.1

From the results given in Table III, it is seen there is not a wide variation in the vitamin D value of market fresh extras as purchased throughout the winter and summer months. The average number of units per egg yolk found was 8.6. On the basis of Steenbock's standard cod liver oil,[8] which contains 45 Steenbock units of vitamin D per teaspoonful, it would require approximately five average market eggs to equal the vitamin D content of one teaspoonful of Steenbock's standard cod liver oil.

THE EFFECT OF STORAGE OF EGGS ON THE VITAMIN D CONTENT

It has been suggested that eggs which are put into cold storage during the summer months, which usually reach the consumer

during the late fall and winter, might contain more vitamin D than fresh eggs laid during the winter months.[9] Accordingly, three cases of eggs, put in commercial storage in April, May and June, 1931, at 29 to 30°, were removed in February, 1932, the average duration of commercial storage. The yolks of two dozen eggs were pooled for each assay. The findings are given in Table IV. For comparison, the antirachitic potency of fresh extras purchased from the same source in April, May and June are also included.

TABLE IV.

STEENBOCK VITAMIN D UNITS PER AVERAGE EGG YOLK

	Storage Eggs	*Fresh Eggs*
	Units	Units
April	11.2	10.0
May	8.5	7.5
June	8.1	9.0

These eggs were laid in April, May and June and kept in storage until the following February, which is usually the end of the storage season.

These results show that the vitamin D content of storage eggs released in February is slightly better than the vitamin D content of fresh eggs purchased at that time. A comparison of the potency of the fresh eggs obtained in the corresponding months of 1932 with those put in storage during those months of 1931 would suggest that there is little or no loss of vitamin D in cold storage. A further study of this problem, placing eggs of definite antirachitic potency in storage, is at present nearing completion.

THE THERAPEUTIC VALUE OF EGGS IN HUMAN RICKETS

On January 21, 1932, a negro, one year of age, was admitted to hospital with marked rickets, showing enlarged epiphyses, Harrison's sulcus, rachitic rosary and curved tibiæ. A roentgenogram of the forearm and wrist joint taken shortly after admittance, which shows florid rickets, is shown in Fig. 1. For six days, from January 21st to January 27th, 3 teaspoonfuls of cod liver oil were given daily. From January 27th to February 4th no cod liver oil was given, but one egg daily from the control group of hens receiving no vitamin D supplement was included in the diet. A previous assay had shown that these eggs had some antirachitic potency. Fig. 2 is a roentgenogram of the forearms of the patient at the end of this period. Some improvement in calcification is shown. From February 4th to March 24th the child received one egg daily from the hens receiving 1 per cent of 250D viosterol. These eggs, as shown in Table I, have excellent antirachitic value by rat assay. Fig. 3 is a plate of the forearms taken at the end of this treatment. It will be seen that the rachitic condition has been entirely alleviated.

SUMMARY

1. The vitamin D content of egg yolk can be markedly increased by the addition of vitamin D to the diet of the hen.

2. Exposure of hens to sunshine or ultraviolet rays from a mercury vapour quartz lamp has little effect in increasing the vitamin D content of egg yolk, in contrast to the results

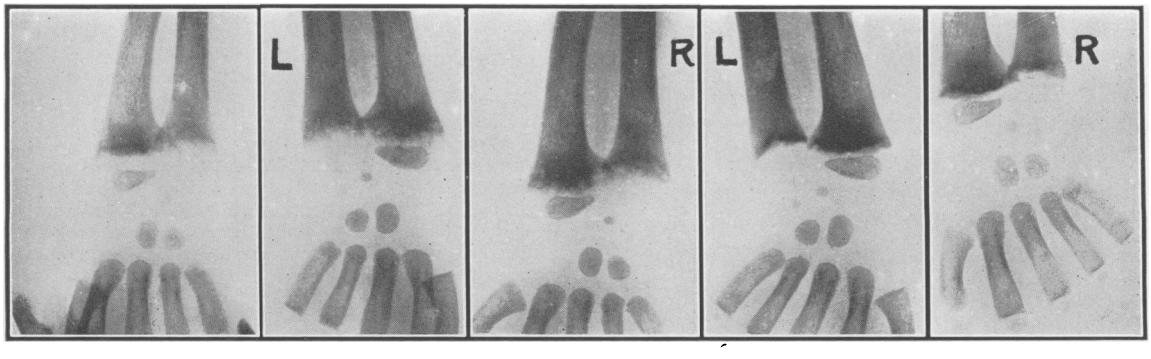

FIG. 1 FIG. 2 FIG. 3

FIG. 1.—Roentgen-ray of left forearm on admission. Marked rickets.

FIG. 2.—Roentgen-ray of forearms after treatment with eggs from hens receiving cod liver oil. Healing rickets.

FIG. 3.—Roentgen-ray of forearms after treatment with eggs from hens receiving viosterol. Rickets cured.

obtained by the addition of cod liver oil to the hen's diet.

3. The vitamin D content of market eggs (fresh extras) varied only slightly throughout the year.

4. The average number of Steenbock vitamin D units per average market egg yolk (fresh extras) is 8.6. It would require approximately five of these egg yolks to furnish the vitamin D equivalent of one teaspoonful of Steenbock's standard cod liver oil. By the addition of cod liver oil to the hen's diet the vitamin D content of the egg can be increased more than three fold.

5. There is little or no loss of vitamin D in eggs kept in cold storage for ten months.

REFERENCES

1. MELLANBY, E.: Experimental rickets, Medical Research Council, Special Report Series, No. 61, 1921.
2. HESS, A. F.: The therapeutic value of egg yolk in rickets, *J. Am. M. Ass.*, 1923, **81**: 15.
   HESS, A. F. AND WEINSTOCK, M.: Further experiments on the antirachitic action of yolk of egg, *Proc. Soc. Exp. Biol. Med.*, 1924, **21**: 441.
3. CASPARIS, H., SHIPLEY, P. G. AND KRAMER, B.: The antirachitic influence of egg yolk, *J. Am. M. Ass.*, 1923, **81**: 818.
4. COLLIER, J.: Prevention of weak legs in experimental chickens, *Science*, 1924, **60**: 42.
5. TSO, E.: The value of egg yolk in supplementing diets deficient in calcium, *Am. J. Physiol.*, 1924, **77**: 192.
   TSO, E.: The effect of chemical preservation of eggs upon the stability of their vitamin contents, *Proc. Soc. Exp. Biol. Med.*, 1924, **22**: 263.
6. STEENBOCK, H. AND BLACK, A.: Fat-soluble vitamins, 23. The induction of growth-promoting and calcifying properties in fats and their unsaponifiable constituents by exposure to light, *J. Biol. Chem.*, 1925, **64**: 263.
7. MCCOLLUM, E. V., SIMMONDS, N., SHIPLEY, P. G. AND PARK, E. A.: Studies in experimental rickets, 16. A delicate biological test for calcium-depositing substances, *J. Biol. Chem.*, 1922, **51**: 41.
8. New and Non-Official Remedies, Viosterol, *J. Am. M. Ass.*, 1929, **93**: 693.
9. Kentucky Experimental Station Report; Antirachitic value of egg yolks, 1929, 32.

ROENTGEN RAY DIAGNOSIS OF PLACENTA PRÆVIA*

(WITH REPORT OF TWO CASES)

BY J. FRIEDMAN, M.D. AND D. O. MACDONALD, M.D.,

Montreal

RECENTLY, the placenta has been roentgenologically demonstrated, in animal experiments, by intravenous or intracardiac injection of thorotrast. Various investigators, such as Ehrhardt,[1] Gragert,[2] Heuser,[3] Vajano,[4] *et al.*, have shown that the placenta is capable of absorbing a large amount of the thorium circulating in the blood, of retaining it for hours and days, and of eliminating it. However, the placentography interfered with fetal nutrition and led frequently to abortion. For this reason, and because of the large quantity of thorium required for the visualization of the human placenta, and its slow elimination, this method is not yet suitable for clinical use.

Menees *et al.*[5] demonstrated the placenta by injecting into the amniotic sac about 10 c.c. of a 1:1 solution of U.S.P. strontium iodide through the anterior abdominal wall. The placenta appeared as a filling defect or a flattened area, best seen in profile or oblique view. In their 21 cases they saw no injurious or toxic effects, except in a case of placenta prævia, where probably the placenta had been entered. Kerr and MacKay[6] discontinued this method, as the fetus died in 3 of their 10 cases. They used instead a derivative of iopax, with no untoward effects in their 10 cases, though the injection had a great tendency to terminate the pregnancy.

Snow[7] was able, without any special technique, to visualize the placenta in the routine roentgen examination of 60 pregnancies. Several of his cases were proved by operation. There was no case of placenta prævia in his group.

Ude[8] *et al.* published recently 3 verified cases of placenta prævia which were recognized roentgenologically without injecting any radiopaque substance into the uterine cavity. Since theirs is the only report of this method in the literature, we should like to add 2 similar cases from our own experience.

CASE 1

Mrs. H.H.D., aged 34, para-iii, was admitted to the outdoor department of the Woman's General Hospital on March 15, 1934. Her last menstrual period had occurred in July 15, 1933. About one month before admission, she developed slight vaginal bleeding, which cleared up under bed rest. Physical examination revealed a pregnancy of about 7½ months' duration. The head of the fetus was located in the left lower quadrant, with the back directed to the left. The placental bruit was heard most distinctly in the right lower quadrant. On vaginal examination the cervix was soft and œdematous. A pulsation could be distinguished in the right lower pelvis from a boggy mass continuous with the uterine wall. There was no bleeding from the cervix. The clinical findings therefore indicated the presence of placenta prævia. The patient was referred for roentgenological examination the same day.

* From the Departments of Roentgenology and Obstetrics of the Woman's General Hospital, Montreal.